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A perfect bowl-like submesoscale vortex from seismic reflection transect in the Chukchi Sea, Arctic Ocean

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The eddies are ubiquitous in the ocean and play an important role in the transportation and redistribution of heat, salt, carbon, nutrients and other materials in the global ocean, thus can regulate global climate and affect the distribution of marine organism. Compared with mesoscale eddies, submesoscale vortices (SVs) have smaller spatial and temporal scales, which impose higher requirements on observation and simulation. The oceanic SVs have a strong vertical velocity, which provides an important supply of nutrients in the upper ocean.

Many researchers have studied the SVs in the Arctic Ocean by physical oceanography methods (e.g., *in-situ* measurements and satellite observations). Here, we found a perfect bowl-like SV using a new method named seismic oceanography (SO). SO can use multichannel seismic (MCS) reflection data to produce surprisingly detailed images of water column. Compared with the traditional physical oceanography methods, SO has the advantages of high acquisition efficiency, high lateral resolution (~10 m) and full depth imaging of seawater.

We used MCS data to image the water column in the in autumn Northeast Chukchi Sea, and captured a perfect bowl-like structure with a depth range of ~200-620m. The structure is almost bilaterally symmetric and has dip angles of 4.8° and 5.5° on the left and on the right, respectively. And it has a horizontal scale of about 12 km at the top and 4.5 km at the bottom, and both the top and bottom of it are near horizontal. The reflections are almost blank in its interior, but are intense and very narrow (~30 m thick) at the lateral boundaries. This indicated that the interior water is homogeneous and quite different from that around it. Fortunately, there is an XBT station near the seismic line and collected almost simultaneously (only one day apart) with the seismic line. The XBT station shows obvious high temperature anomaly over 2°C at the depth of 210-700 m. Therefore, we concluded the structure is a subsurface warm SV, i.e. anticyclonic warm eddy, and may be a submesoscale coherent vortex (SCV). The anomalies from the surrounding water masses indicate that the SV was created at the edge of the Arctic Ocean and then advected here.

In addition, we used Rossby number (Ro) and Okubo-Weiss (OW) parameter calculated from daily-averaged re-analysis hydrographic data (~3.5 km of grid spacing at 75°N) from Copernicus Marine Environment Monitoring Service (CMEMS) to analyze the SV. Result shows that the values of the Ro and OW parameter in the area of the SV are both negative. This also suggests that this SV is an anticyclone. This submesoscale anticyclonic vortex may be generated from the friction effect between the warm inflow from the North Pacific and the right wall of Barrow Canyon after passing

through the Bering Strait, and then transported to the Northeast of Chukchi Sea by the Beaufort Gyre.